Magma Starved Rifting: Galicia/Newfoundland Breakup and Initiation of Seafloor Spreading

An International Collaboration to Complement GeoPRISMS ENAM Science

Dale Sawyer
Rice University

Future work: 3D MCS and wide-angle study of the Galicia S detachment

Major Collaborators

US: Dale Sawyer, Juli Morgan, Donna Shillington (Rice, LDEO)

UK: Tim Reston, Tim Minshull, Marta Perez Gusinye, Rob Hardy, Jonathan Bull, Carl Stevenson (Birmingham, Southhampton)

Germany: Dirk Klaesen (GEOMAR)

Spain: Cesar Ranero (Barcelona)

Portugal: Luis Pinheiro (Univ. of Porto)

Future work: 3D MCS and wide-angle study of the Galicia S detachment

International Contributions

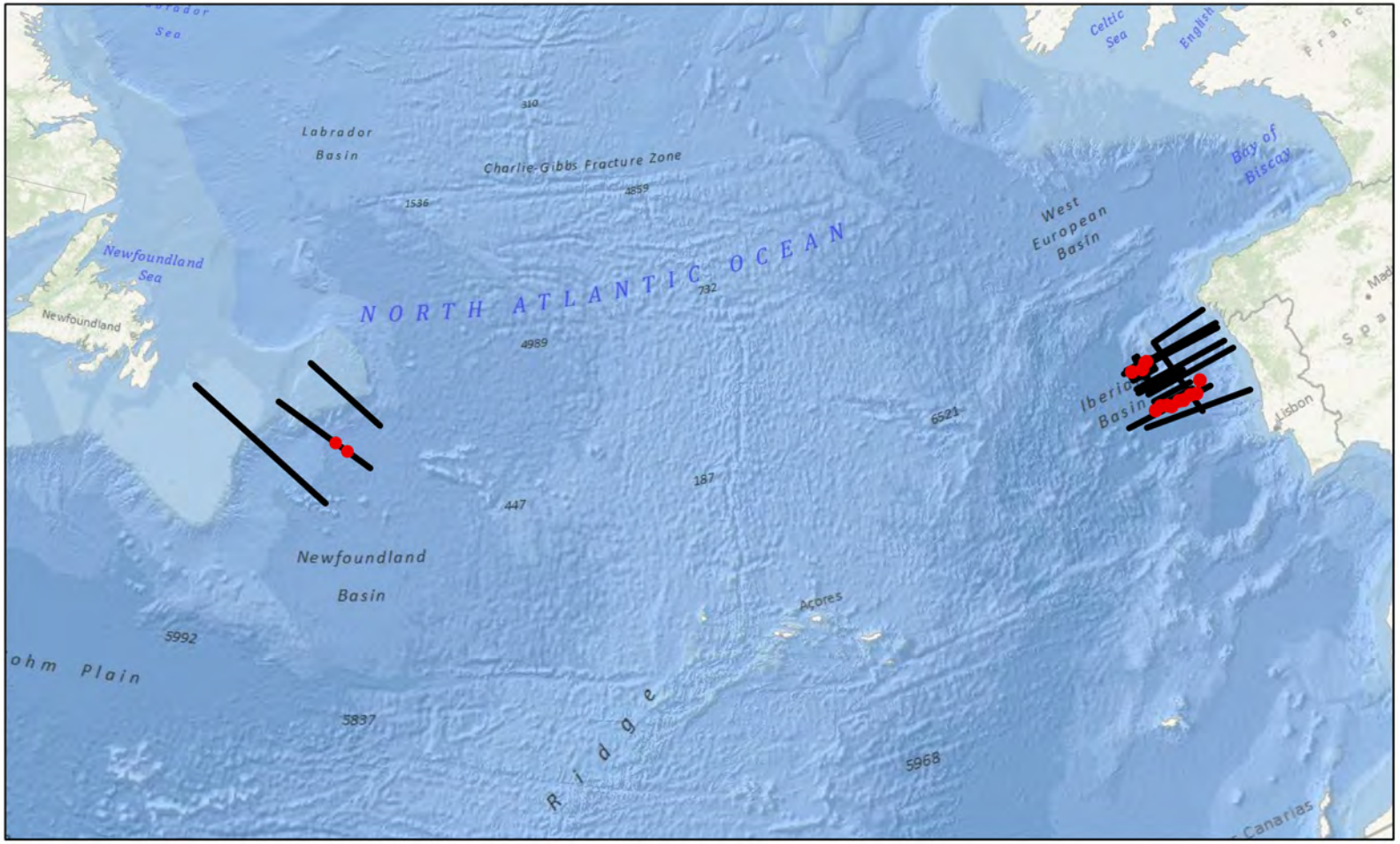
- US: 42 days of *RV Langseth* 3D acquisition and US science costs. Highly ranked at NSF – MG&G. Tentatively scheduled to sail in June 2013.

- UK: £1,330,000 for ~50 OBS's, basic 3D seismic data processing, UK science costs. Awarded by NERC

- Germany: 37 days of *RV Poseidon* (OBS ship), ~30 OBS's, German science costs. Ship is Scheduled, SCIENCE PROPOSED

SCREECH MCS & OBS Survey
IODP Leg 210 Drilling

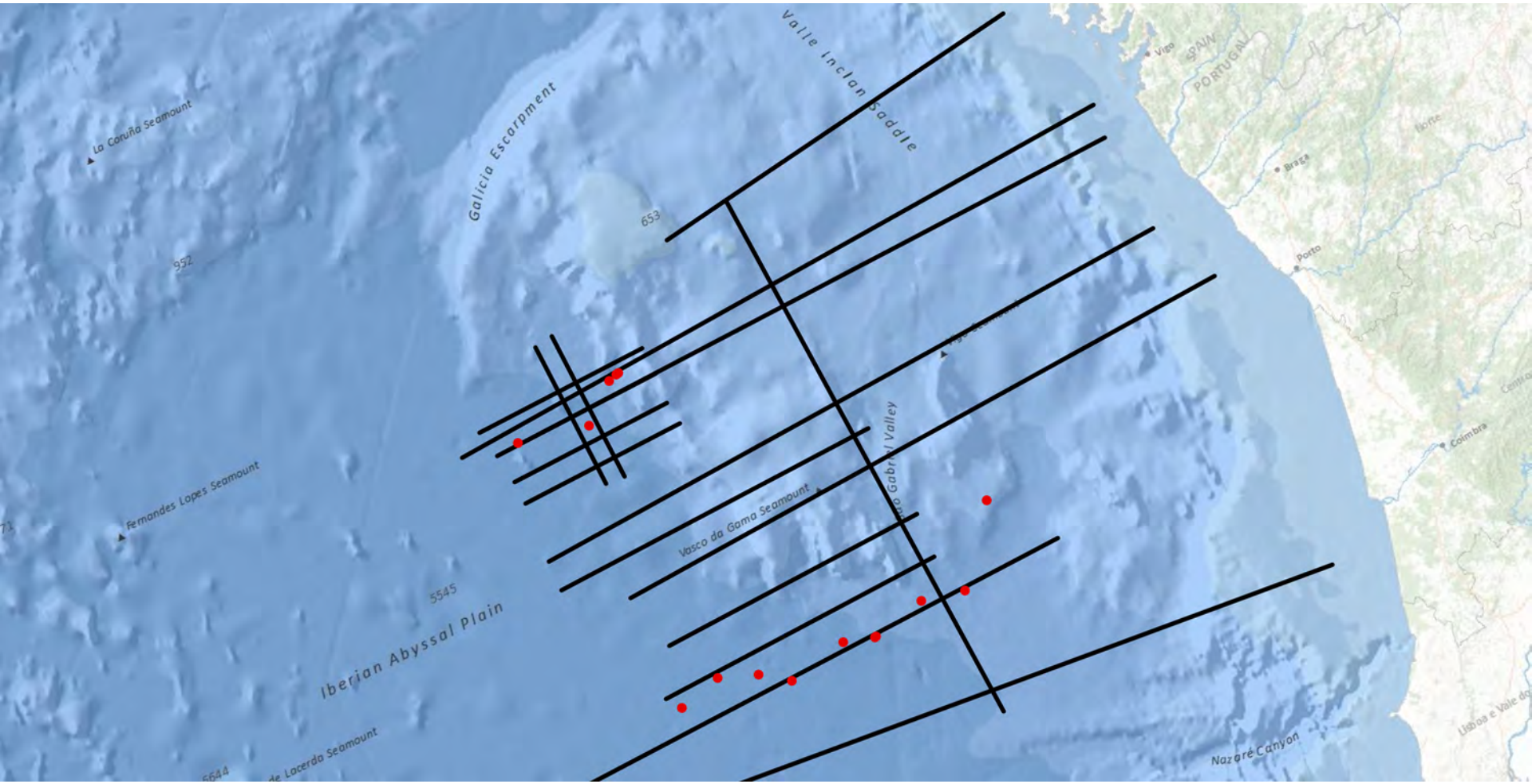
Five MCS Surveys, several including OBS's
ODP Legs 103, 149 & 173 Drilling



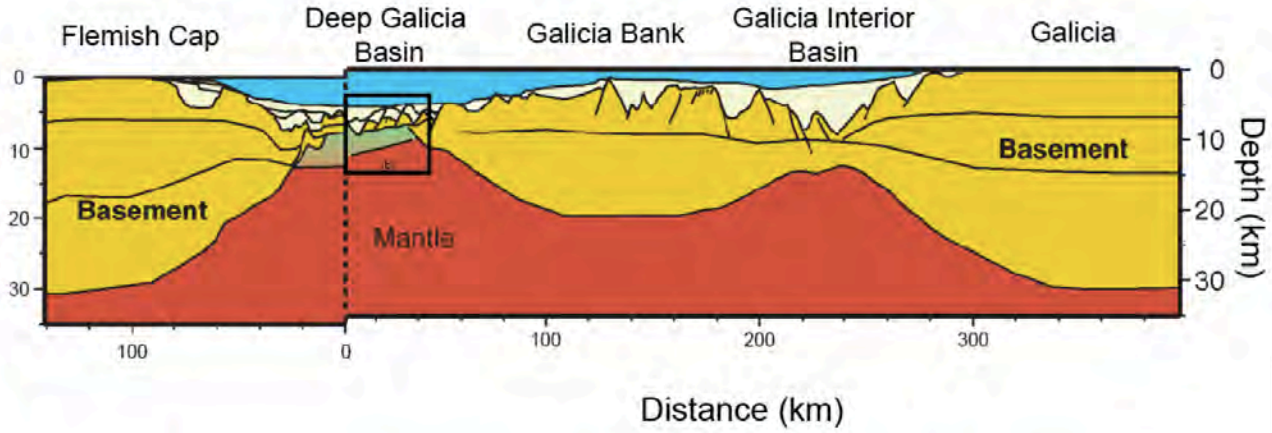
Newfoundland/Grand Banks Margin

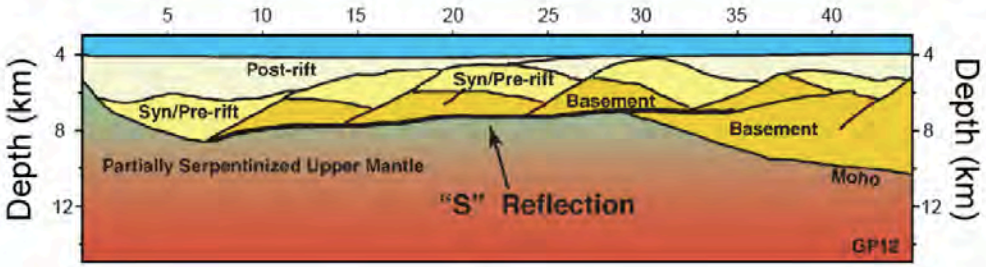
Iberia Margin

Iberia Margin

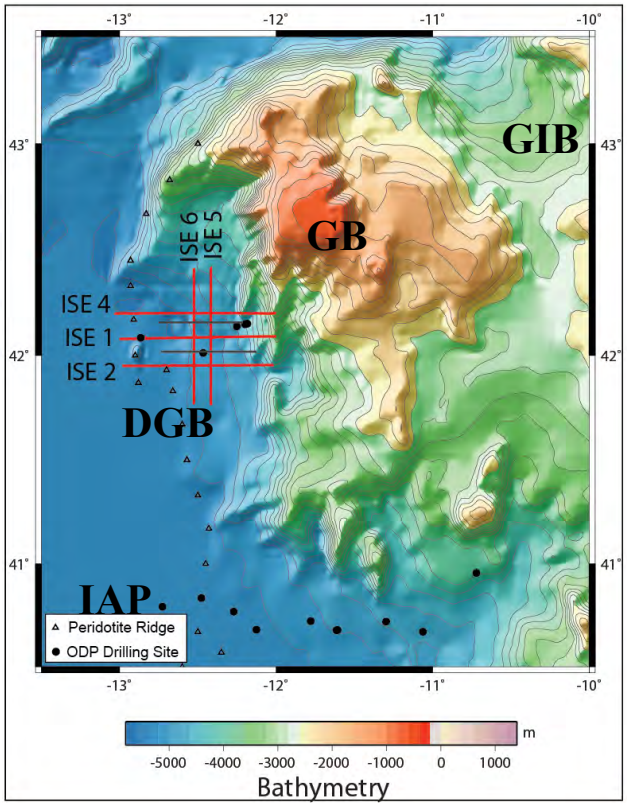


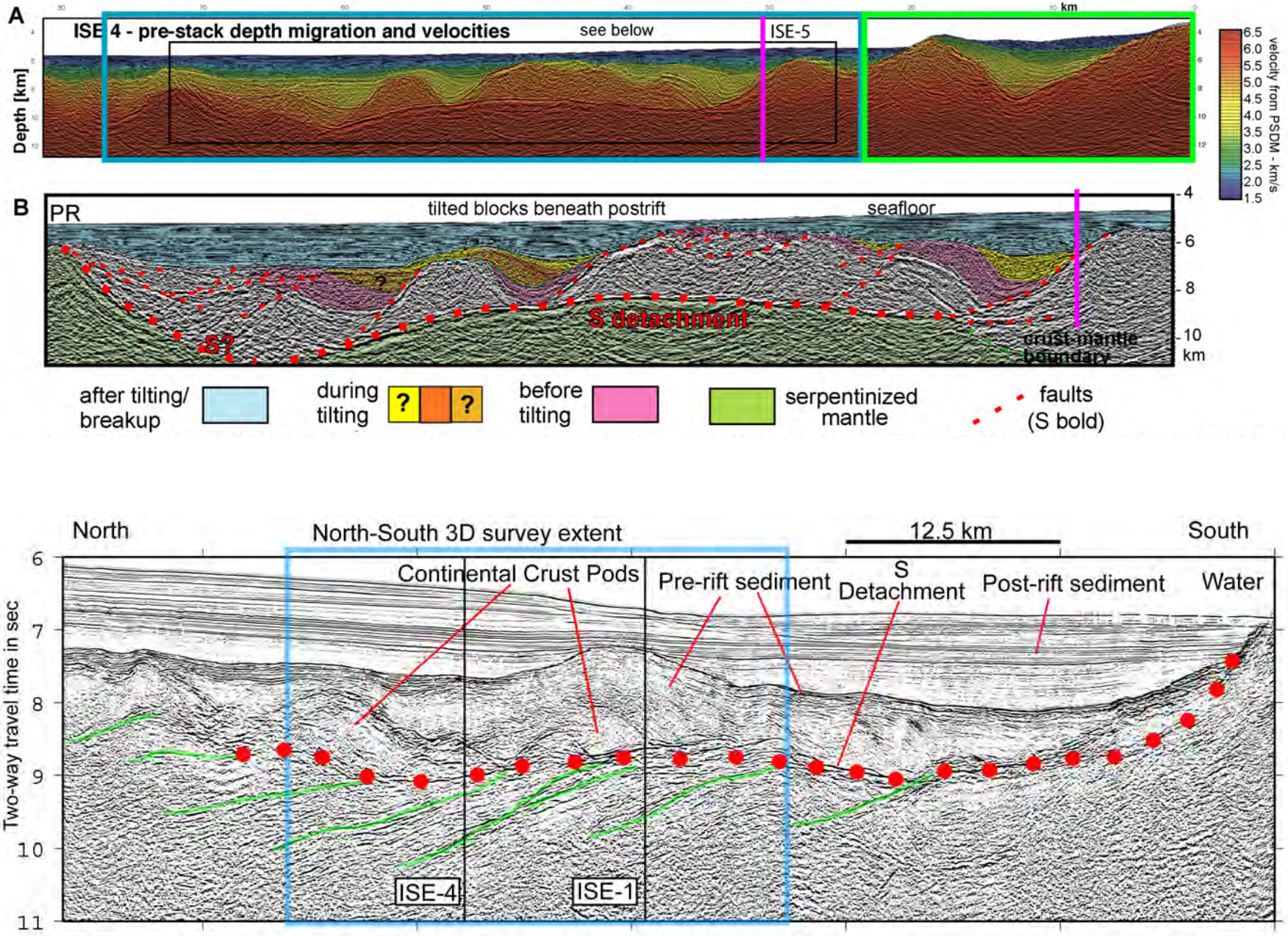
MCS profiles in black (many include OBS's).
Scientific Ocean Drilling sites in red.

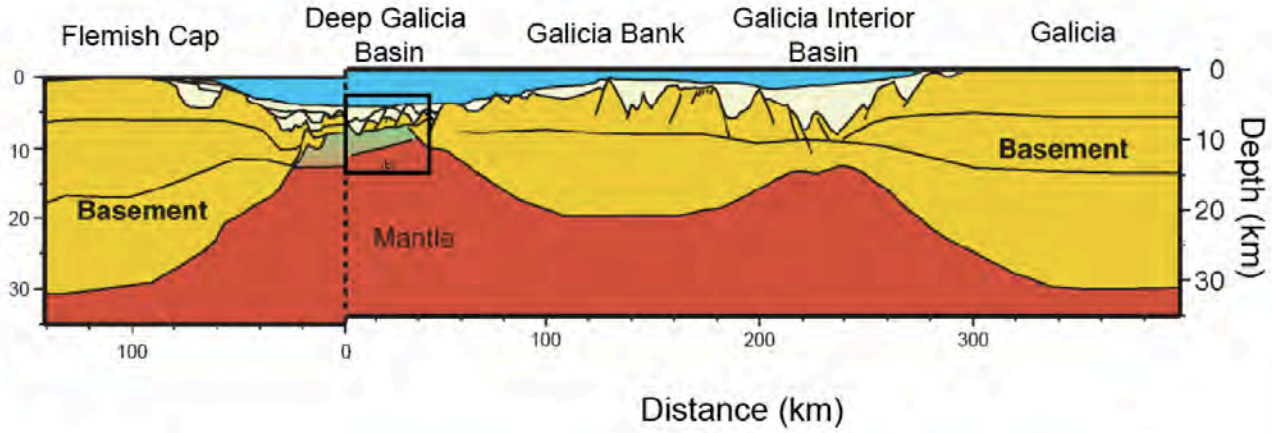


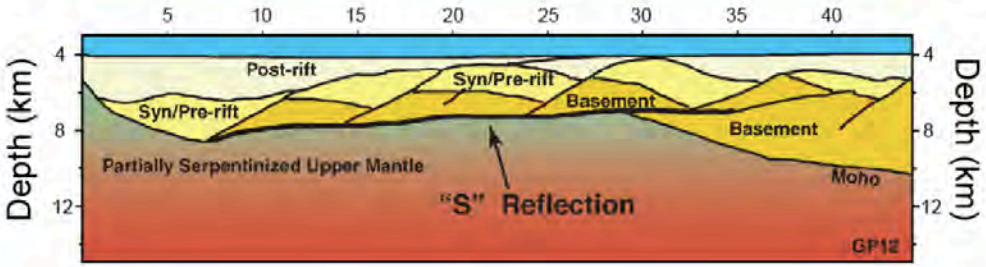


Interpreted cross sections modified from Hopper et al. [2006, Figure 6]




A
ISE 4 - pre-stack depth migration and velocities
see below
ISE-5
Depth [km]
km
velocity from PSDM - km/s
6.5
6.0
5.5
5.0
4.5
4.0
3.5
3.0
2.5
2.0
1.5
B
PR
tilted blocks beneath postrift
seafloor
S detachment
S?
crust-mantle boundary
km
after tilting/ breakup
during tilting
before tilting
serpentinized mantle
faults (S bold)
North
North-South 3D survey extent
12.5 km
South
Continental Crust Pods
Pre-rift sediment
S Detachment
Post-rift sediment
Water
Two-way travel time in sec
ISE-4
ISE-1





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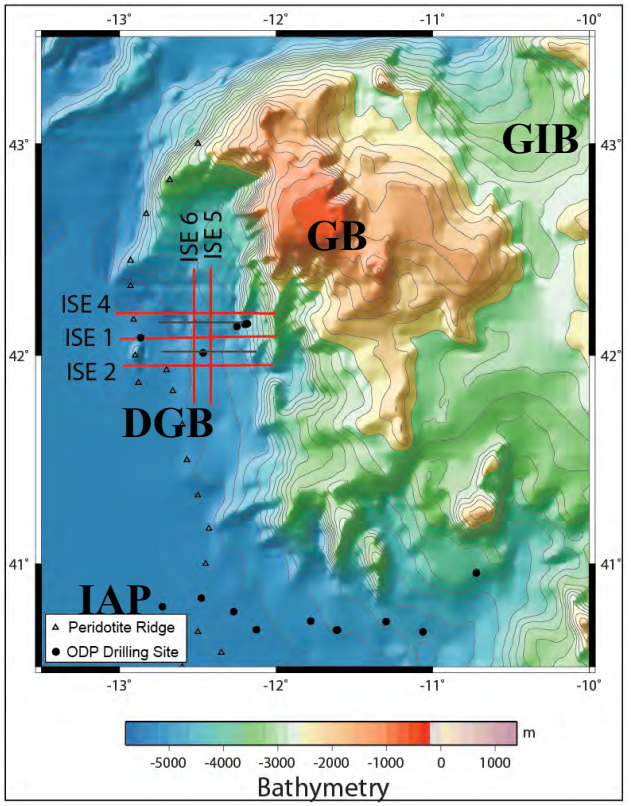
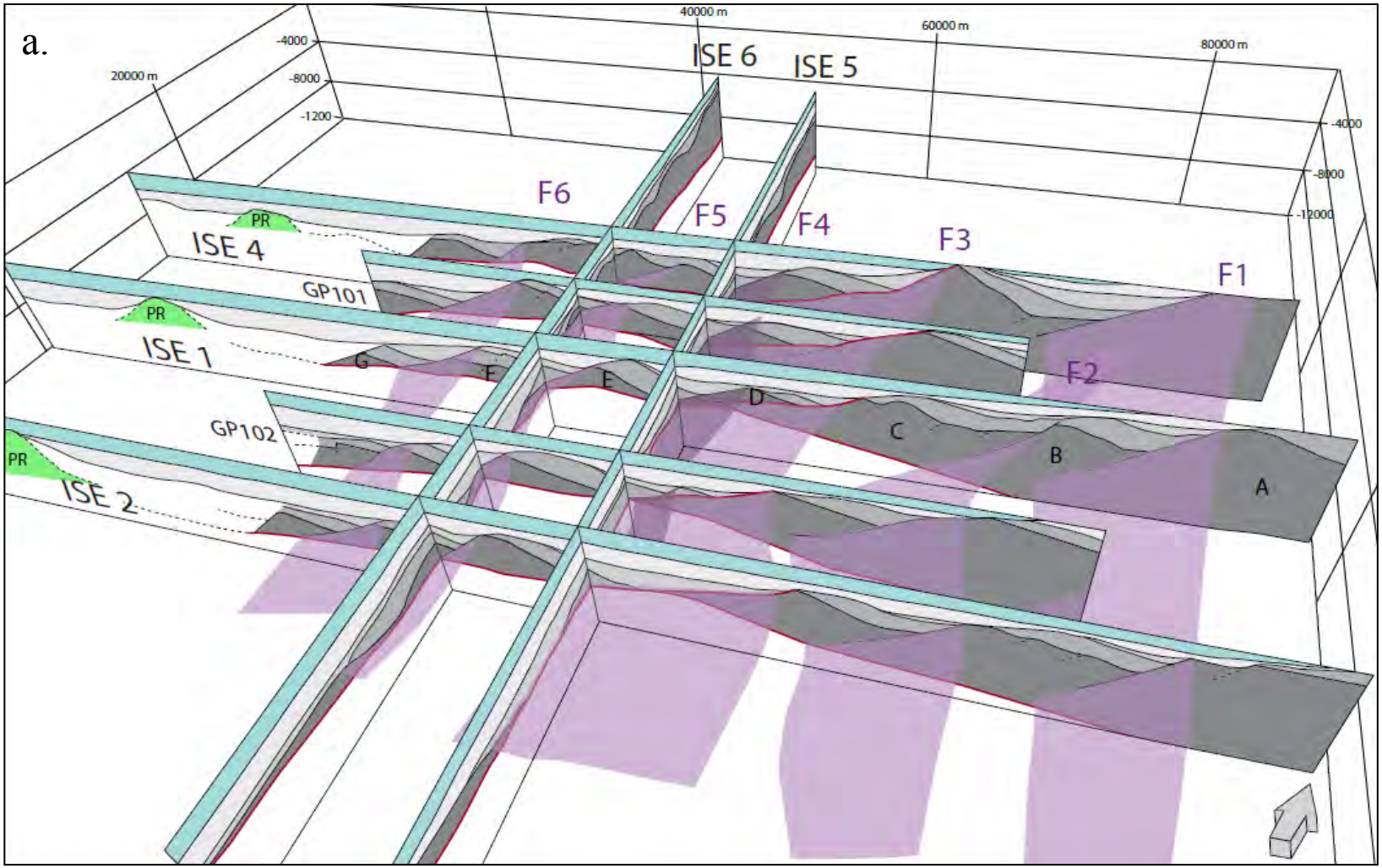



a.
20000 m
40000 m
60000 m
80000 m
-4000
-8000
-1200
-12000
ISE 6
ISE 5
ISE 4
ISE 1
ISE 2
PR
GP101
GP102
F6
F5
F4
F3
F2
F1
G
F
E
D
C
B
A

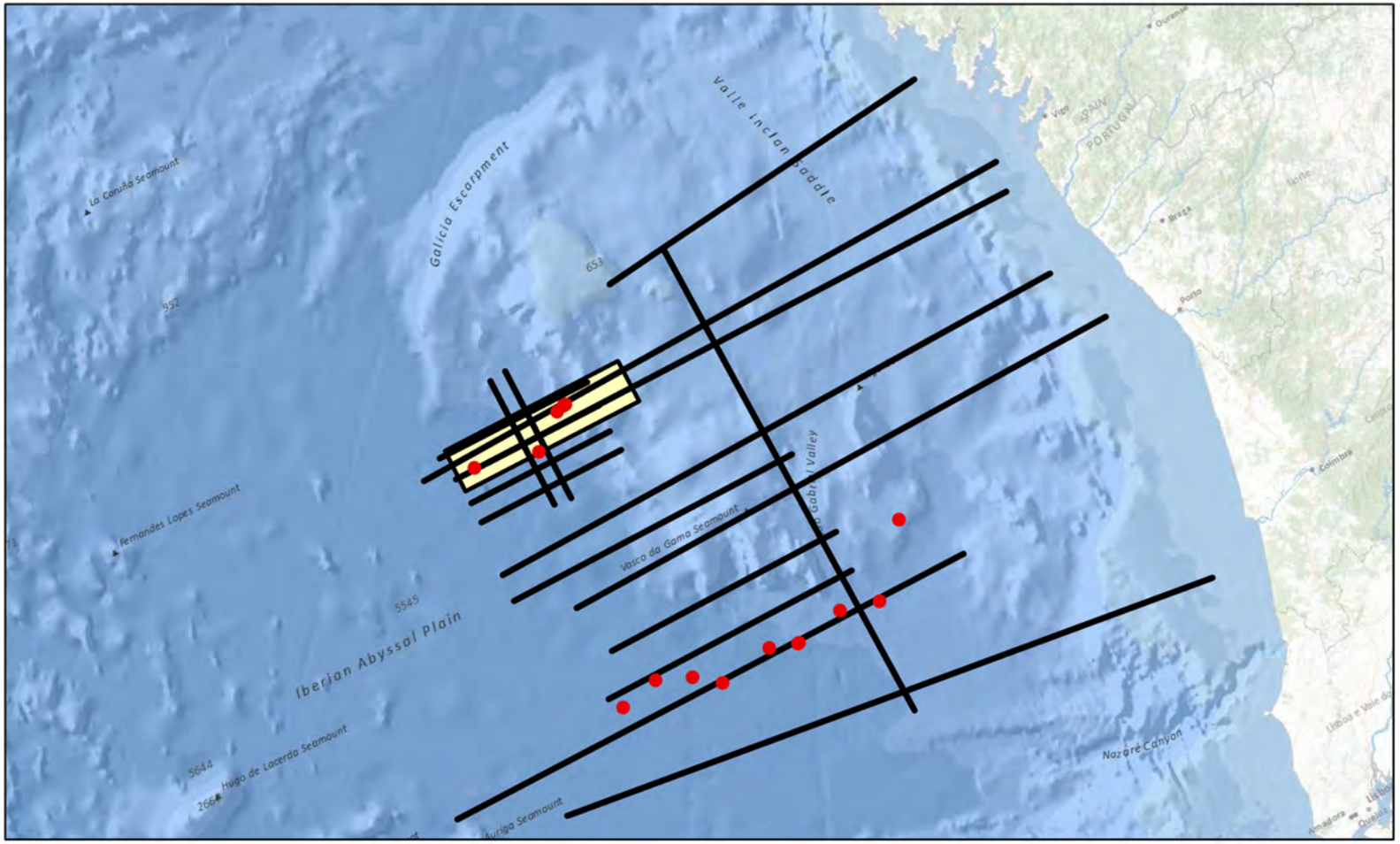
Hypotheses related to late stage faulting processes

Hypothesis 1: The S detachment was active at a low angle (<20º; Reston et al., 2007).

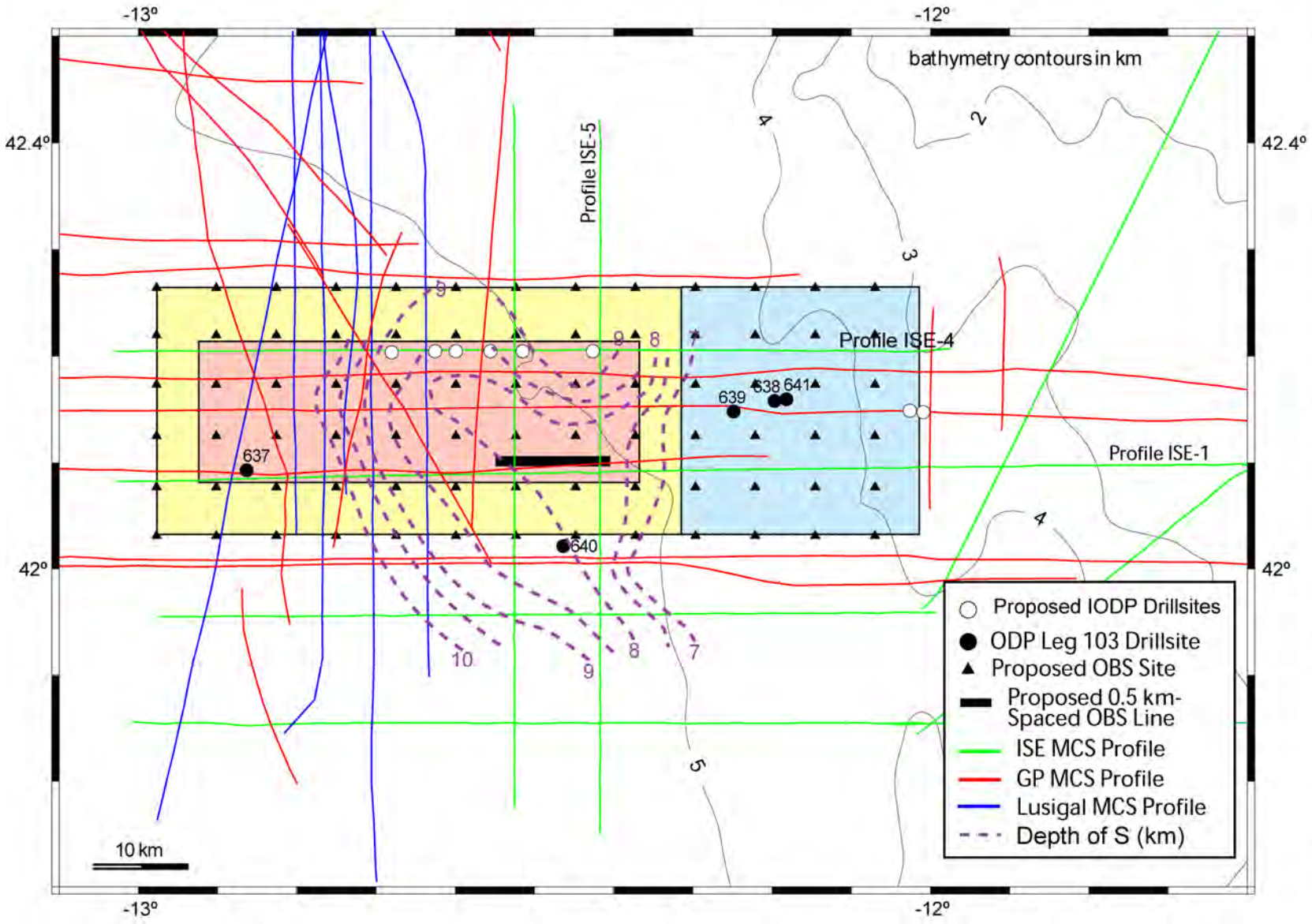
Hypothesis 2: Differences between the degree of extension estimated from fault heaves in the upper crust and whole crustal and lithospheric extension estimated from wide-angle seismic data and subsidence can be explained by polyphase faulting (Reston, 2005).

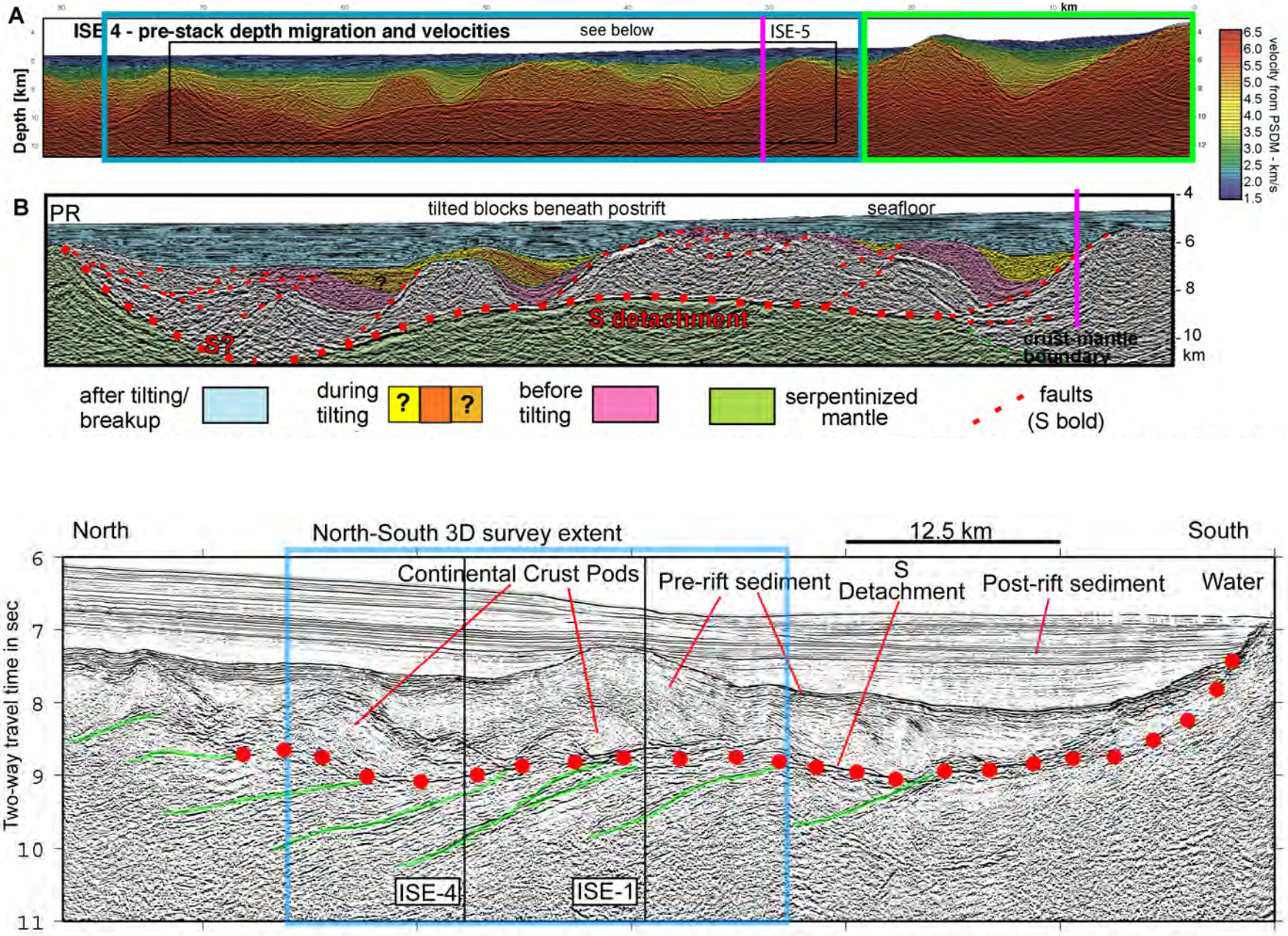
Hypothesis 3: The crustal blocks above the S detachment have formed in a "rolling hinge" manner (Buck, 1988; Manatschal et al., 2001; Lavier and Manatschal, 2006).

Potentially affecting each of these hypotheses are recent interpretations of large scale landsliding affecting the west and south sides of the Galicia Bank (Sawyer et al., 2005; Clark et al, 2007).


La Coruña Seamount
Galicia Escarpment
Valle Inclan Saddle
653
992
Fernandes Lopes Seamount
Vasco da Gama Seamount
Tagus Abyssal Valley
5545
Iberian Abyssal Plain
5644
2668
Hugo de Lacerda Seamount
Auriga Seamount
Nazaré Canyon
SPAIN
PORTUGAL
Ourense
Viseu
Braga
Porto
Coimbra

3D Reflection and Long Offset (OBS) Seismic Survey Plan

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PR
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crust-mantle boundary
km
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North-South 3D survey extent
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Continental Crust Pods
Pre-rift sediment
S Detachment
Post-rift sediment
Water
Two-way travel time in sec
ISE-4
ISE-1

What do we expect to learn?

- We can learn about the late stages of continental breakup and the initiation of seafloor spreading.

- We can learn about the mechanisms that exhume upper continental mantle at the seafloor.

- We can learn about the pathways by which water becomes available for serpentinizing a substantial thickness of upper mantle rocks.

- We can learn whether normal faults can move at very low angle during late stage continental breakup.

- With 3D seismic data, we can choose optimal locations for drilling to the synrift sediments (for dating rifting events) and to the S detachment (sampling a probable low angle normal fault).

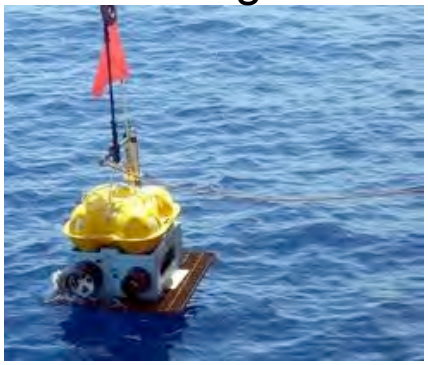
United States

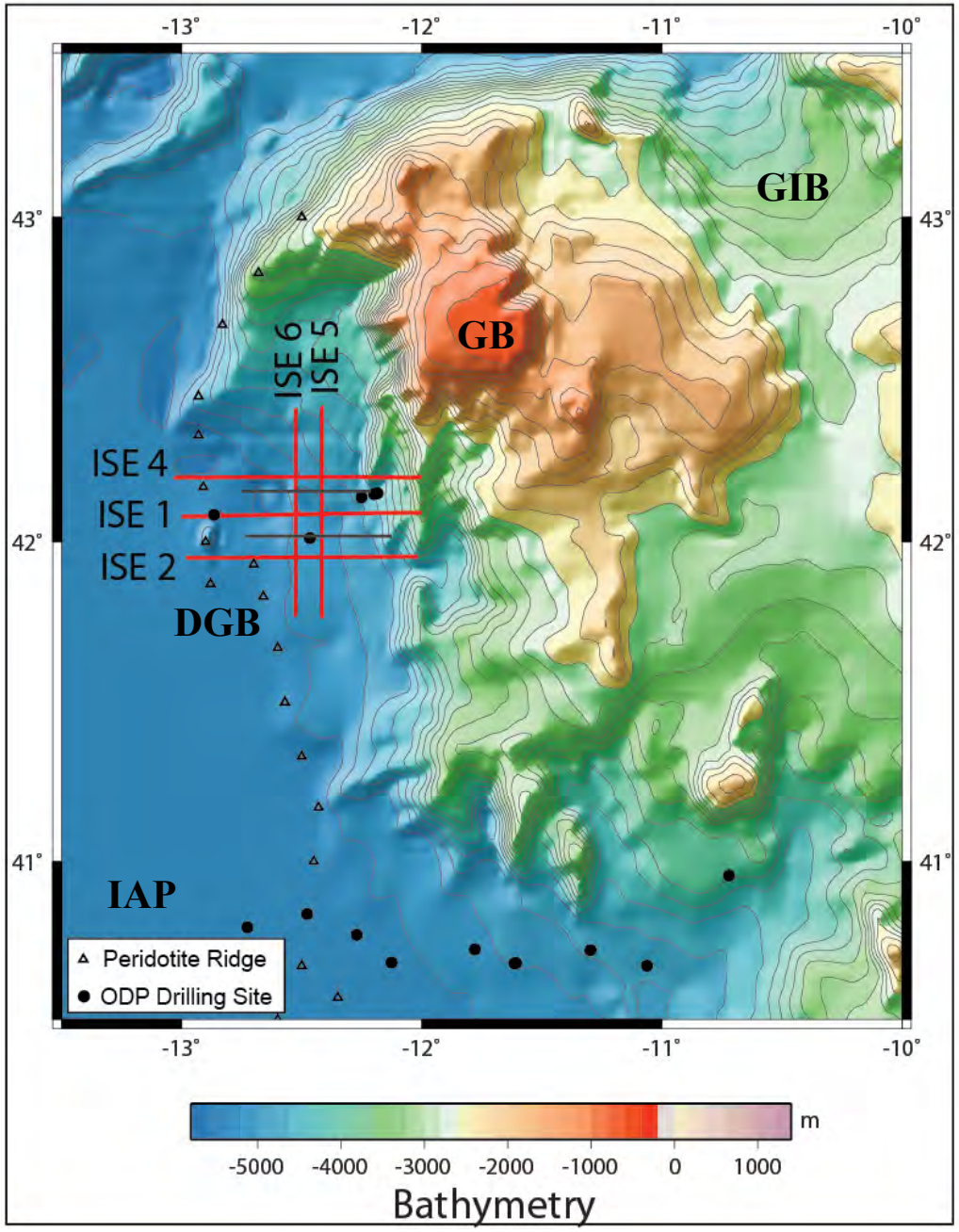
Germany

International scientific collaborations can extend our reach!

Germany

United Kingdom




-13°
-12°
-11°
-10°
43°
42°
41°
GIB
GB
ISE 6
ISE 5
ISE 4
ISE 1
ISE 2
DGB
IAP
Peridotite Ridge
ODP Drilling Site
m
-5000
-4000
-3000
-2000
-1000
0
1000
Bathymetry